NWS-R435-PR-SP001

APPENDIX D

CAST-IN-PLACE CONCRETE SPECIFICATION

1 JULY 2000

Prepared by:
DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE
1325 EAST-WEST HIGHWAY
SILVER SPRING, MD
20910-3283

TABLE OF CONTENTS

LIST OF TABLES

D1.0 SCOPE

This Specification defines the requirements for furnishing and installing cast-in-place concrete.

D2.0 GENERAL REQUIREMENTS

D2.1 Concrete Installation Requirements

All concrete installation requirements shall be accomplished for the installation of the Doppler weather radar system, to include the following:

a. Furnish all the necessary materials, tools, and equipment required for all cast-in-place concrete work;

b. Furnish, transport, place, consolidate, and finish all concrete;

c. Design, furnish, fabricate, install, and remove all formwork, and bracing;

d. Furnish, fabricate, and install all reinforcing steel and all necessary supports for reinforcing steel;

e. Install all embedded anchor bolts, sleeves, and miscellaneous metal;

f. Furnish and install all joint fillers and joint sealers;

g. Prepare site drawings (to include supporting fabrication and placement drawings) of all reinforced steel; and

h. Furnish testing services.

D2.2 Applicable Documents

This section lists all the applicable documents referenced elsewhere in this Specification. The current issue of the following documents, together with their first tier references, form a part of this Specification to the extent specified herein. Unless specifically stated otherwise, the version of the document that applies is the version in effect on the date of issue of the solicitation.

The following documents are available from the sources shown.

a. Federal Specifications

TT-S-00230C Sealing Compound: Elastomeric Type, Single-Component (For Calking, Sealing, and Glazing in Buildings and Other Structures)

Source: Defense Automation and Production Service
Building 4/D
700 Robbins Avenue
Philadelphia, PA 19111-5094.

Internet Address:

http://astimage.daps.dla.mil/quicksearch

b. American Concrete Institute (ACI)

211.1-91 Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete

304.3R-96 High Density Concrete: Measuring, Mixing, Transporting, and Placing

305R-91 Hot Weather Concreting

306.1-90 Standard Specification for Cold Weather Concreting

306R-88 Cold Weather Concreting

308-92 Standard Practice for Curing Concrete

309.3R-92 Guide to Consolidation of Concrete in Congested Areas

309R-96 Guide for Consolidation of Concrete

318-99/ 318R-99 Building Code Requirements for Structural Concrete & Commentary

347R-94 Guide to Formwork for Concrete

SP-66(94) ACI Detailing Manual

Source: ACI International®
PO Box 9094
Farmington Hills, MI 48333
248-848-3700

Internet:

http://www.aci-int.org/

c. American Society for Testing and Materials (ASTM)

A185-97 Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement

A615/ A615M-00 Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

C31/ C31M-98 Standard Practice for Making and Curing Concrete Test Specimens in the Field

C33-99ae1 Standard Specification for Concrete Aggregates

C39/ C39M-99 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

C94/ C94M-00 Standard Specification for Ready-Mixed Concrete

C143/ C143M-98 Standard Test Method for Slump of Hydraulic Cement Concrete

C150-99a	Standard Specification for Portland Cement
C171-97a	Standard Specification for Sheet Materials for Curing Concrete
C173-94ae1	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
C231-97e1	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
C260-00	Standard Specification for Air-Entraining Admixtures for Concrete
C309-98a	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
C494/	Standard Specification for Chemical Admixtures for C494M-99a Concrete
D1752-84 (1996)e1	Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
D2103-97	Standard Specification for Polyethylene Film and Sheeting
E329-00	Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

Source: ASTM
100 Barr Harbor Drive
West Conshohocken, PA 19428-2959
610-832-9585

Internet:
http://www.astm.org

d. National Ready Mixed Concrete Association

Quality Control Manual - Section 3:
Check List for Certification of Ready Mixed Concrete
Production Facilities

Source: National Ready Mix Concrete Association
900 Spring Street
Silver Spring MD 20910
301-587-1400 or 888-84NRMCA (846-7622)

D2.3 Quality of Concrete Construction

Quality of concrete shall be determined based on conformance with the requirements of this Specification and on the results of strength tests performed, as specified, on samples of concrete taken at its final point of discharge into the foundations.

Government approvals of materials and design mixes shall in no way reduce the requirement for furnishing concrete of specified quality.

In the event that materials not conforming to the requirements of this Specification are found to have been included in concrete already in place, and if the inclusion of such materials could reasonably be expected to lead to the deterioration of the concrete, remedial measures, as approved by the Government, shall be taken to correct the deficiency. All such remedial measures shall be at no additional cost to the Government.

In the event that the results of strength tests, performed as specified herein, indicate that concrete does not conform to the requirements of this Specification, remedial measures, as approved by the Government, shall be taken to correct the deficiency. All such remedial measures shall be at no additional cost to the Government.

D3.0 DETAILED REQUIREMENTS

All cast-in-place concrete work shall be completed in accordance with Contractor prepared and Government approved site drawings. Government approval of site drawings does not relieve the Contractor of meeting Specification requirements.

D3.1 Materials for Concrete

All materials used for concrete work shall be new.

D3.1.1 Cement

Cement shall be Portland cement conforming to ASTM C150, TYPE II, including optional chemical requirements.

D3.1.2 Aggregates

Fine and coarse aggregates shall be regarded as separate ingredients. Each size of coarse aggregate, and the combination of sizes when two or more are used, shall conform to specified grading requirements.

Aggregates for normal weight concrete shall conform to ASTM C33, except as modified herein.

Limits for deleterious substances in fine aggregate shall be as follows:

Item	Weight Percent of Total Sample, Max
Clay lumps and friable particles	2.0
Material finer than No. 200 sieve	3.0
Coal and lignite (and lightweight particles)	0.5
Total of all deleterious substances	3.0

Limits for deleterious substances in coarse aggregate shall be as follows:

Item	Weight Percent of Total Sample, Max
Clay lumps and friable particles	2.0
Chert (as defined in ASTM C33)	1.0
Material finer than No. 200 sieve	1.0
Coal and lignite	0.25

Coarse aggregate shall not contain any materials that are deleteriously reactive with the alkalies in the cement in an amount sufficient to cause excessive expansion of mortar or concrete.

D3.1.3 Water

Mixing water shall be free from injurious quantities of oil, alkali, vegetable matter and salt. Non-potable water shall not be used in mixing concrete.

D3.1.4 Admixtures

Air-entraining admixture shall conform to ASTM C260.

Water-reducing, retarding, and accelerating admixtures shall conform to ASTM C494.

Pozzolanic admixtures shall not be used as an admixture.

Calcium chloride shall not be used as an admixture.

Admixtures shall be essentially free of chlorides. Admixture manufacturers shall state in writing the chloride content of the admixture and whether or not chloride as been added during its manufacture.

Descriptions of admixtures proposed for use in the work shall require Government approval.

Admixtures used in the work shall be of the same composition as those used in establishing the required concrete proportions.

D3.1.5 Control, Handling, and Storage of Materials

Control, handling, and storage of materials shall conform to the recommendations of ACI 304.

D3.2 Proportioning

D3.2.1 General

Concrete, of the various compressive strengths required, shall be of the specified quality, and shall be capable of being placed without segregation and, when hardened, of developing all of the characteristics required by this Specification.

D3.2.2 Materials

Materials used to establish the proportions of ingredients for the various strengths and types of concrete shall be as specified and shall be the materials used for the production of concrete.

D3.2.3 Durability

All concrete shall be air-entrained. Air-entrainment shall be by addition of air-entraining admixture at the mixer. Air content shall be as required in ACI 318, and shall be measured at the point of discharge of concrete in accordance with ASTM C231, ASTM C173, or ASTM C138.

Water-cement ratios for the various compressive strengths of concrete shall conform to the recommendations of ACI 211.1. Maximum permissible water-cement ratios for concrete in severe exposures shall be as recommended in ACI 211.1, for the conditions as described therein.

D3.2.4 Slump

Concrete shall be proportioned and produced to have a slump of four inches or less. A tolerance of up to one inch above the indicated maximum shall be allowed for one batch in any five consecutive batches tested.

Slump shall be determined in accordance with ASTM C143.

D3.2.5 Admixtures

All admixtures, as specified in D3.1.4, shall be used in accordance with the manufacturer's instructions.

Concrete mix shall be designed for the normal rate of hardening at 70 degrees F. Contractor shall adjust quantities of admixtures as required to provide for variations in temperature and humidity that might affect the rate of hardening, the workability, or the quality of concrete.

D3.2.6 Selection of Proportions

Proportions of ingredients for concrete shall be established in accordance with the requirements of ACI 318.

D3.3 Formwork

D3.3.1 General

Formwork shall conform to the recommendations of ACI 347. Forms shall confine the concrete and shape it to the required dimensions. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete. Approved site drawings shall identify earth cuts to be used as forms for vertical surfaces.

D3.3.2 Design and Installation

Design, engineering, and construction of formwork shall be required.

Forms shall be wood, metal, structural hardboard, or other material as approved by the Government. Form facing materials shall be non-reactive with concrete.

Forms shall be sufficiently tight to prevent the loss of mortar from concrete.

Chamfer strips shall be placed in corners of forms to produce beveled edges on exposed surfaces.

Positive means of adjustment (wedges or jacks) of shores and struts shall be provided and all settlement shall be taken up during concrete placement operations. Forms shall be securely braced against lateral deflections. Wedges shall be fastened in position prior to placement of concrete.

D3.3.3 Removal of Forms

In no case shall forms be removed less than 48 hours after concrete placement.

D3.4 Reinforcement

D3.4.1 General

Approved site drawings, shall identify all fabrication dimensions and locations for placing of reinforced steel and accessories. Reinforcement steel shall not be fabricated prior to approval of site drawings by the Government.

Details of reinforcing steel shall be in accordance with ACI 315 and shall meet the requirements of ACI 318.

D3.4.2 Reinforcing Steel

Approved site drawings shall identify the sizes and shapes of reinforcing steel.

Reinforcing steel shall meet the applicable requirements of ACI 318, and as specified herein.

Reinforcing bars shall be deformed bars conforming to ASTM A615, Grade 60 and Supplementary Requirement S1.

Welded wire fabric shall conform to ASTM A185.

D3.4.3 Fabricating and Placing Tolerances

Reinforcing bars shall be fabricated in accordance with the tolerances given in ACI 315.

Reinforcing bars shall be placed within tolerances conforming to the requirements of ACI 318 and the following:

Minimum spacing between bars:	As required by ACI 318 ±1/4 inch
Spacing crosswise of members:	Spaced evenly within 2 inches

Bars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If bars are moved more than one bar diameter, or enough to exceed the specified tolerances, the resulting arrangement of bars shall be subject to approval by the Government.

D3.4.4 Placing

Approved site drawings shall identify the placing of reinforcement as specified herein.

Minimum concrete cover for reinforcement shall conform to the requirements of ACI 318.

At the time concrete is placed, reinforcement shall be free of mud, oil, or other materials that might adversely affect, or reduce bond. Reinforcement with rust, mill scale, or a combination of both shall be satisfactory without cleaning or brushing provided the dimensions and weights, including heights of deformations of a cleaned sample shall not be less than required by the referenced specification for reinforcing steel.

Reinforcement shall be supported and fastened together to prevent displacement, by construction loads or concrete placement, beyond the specified tolerances. Bars shall be tied, with wire-ties, at intersections (at approximately 24 inches) and at contact lap splices. Tie wires shall be 16 AWG black annealed wire.

Reinforcement supported from the ground shall rest on precast concrete blocks not less than four-inches square, and have a compressive strength equal to that of the concrete being placed. Where concrete surfaces are exposed to weather in the finished structure, the portions of all accessories within one-half inch of those concrete surfaces shall be noncorrosive or protected against corrosion.

Welded wire fabric shall be overlapped, where successive mats or rolls are continuous, in such a way that the overlap measured between outermost cross wires of each fabric sheet is not less than the spacing of the cross wires plus two inches. Welded wire fabric shall be supported as required for reinforcing bars.

Approved site drawings shall identify splices of reinforcing bars as specified herein.

Continuous reinforcing bars, #11 and smaller, shall be spliced by lapping unless otherwise indicated on the approved site drawings. Lap length shall not be less than Class B splice. Lapped splices shall be in accordance with the requirements of
ACI 318.

D3.5 Joints and Embedded Items

D3.5.1 Construction Joints

Approved site drawings shall identify the location of all construction joints. Construction joints not shown on the approved site drawings shall be located in conformance with structural requirements and shall be shown on approved site drawings and be subject to approval by the Government.

Approved site drawings shall identify where reinforcement shall be continued across construction joints.

The surface of the concrete at all construction joints shall be thoroughly cleaned and all latence removed prior to placing adjoining concrete.

Bond, between new concrete and concrete that has set, shall be obtained, as required or approved by the Government, by either of the following methods:

a. Roughing the surface of the concrete in a manner that shall expose the aggregate uniformly and shall not leave latence, loosened particles of aggregate, or damaged concrete at the surface; or the

b. Use of an adhesive.

D3.5.2 Expansion Joints

Approved site drawings shall identify all expansion joints. Joint filler and sealer, as specified, shall be installed in all expansion joints unless otherwise indicated on the approved site drawings.

Joint filler shall be preformed cork conforming to ASTM D1752, Type II. Joint sealer shall be a one-component polyurethane-base sealant Type 1, Class A conforming to Federal Specification TT-S-00230C.

If alternate filler and/or sealer is proposed for use, documentation that the proposed materials are compatible for use together shall be required.

D3.5.3 Other Embedded Items

All sleeves, inserts, anchors, and other embedded items, including those required for adjoining work, or for its support, shall be in place prior to placement of concrete. Approved site drawings (including any supporting fabrication and placement drawings prepared by miscellaneous metal vendors) shall identify the placement of anchor bolts, sleeves, and other items of miscellaneous metal for installation.

All work required to be installed before concrete is placed shall be verified prior to placement of concrete.

Anchor bolts shall be maintained free from any deformation; and free from loose rust, loose scale, oil, mud, and any other deleterious substances. Anchor bolt threads shall be greased at the projection ends of the anchor bolts; any such other protection as may be required to maintain the anchor bolts in the proper condition until their incorporation into the concrete shall also be provided.

Approved site drawings shall identify the use of all templates and devices necessary for the accurate positioning and setting of all embedded items specified herein.

D3.5.4 Placing Embedded Items

Expansion joint material and other embedded items shall be positioned accurately and supported against displacement.

Anchor bolts shall be in alignment within a tolerance of one-sixteenth inch per foot of projection above the surface of the concrete. Location of anchor bolts, at the surface of the concrete, shall be within a tolerance of one-sixteenth inch from the location shown on the approved site drawings. Ends of anchor bolts shall be within a tolerance of plus or minus one-quarter inch from the dimensions shown on the approved site drawings. Anchor bolts not meeting all of the specified requirements shall be rejected, and shall be repaired or replaced in accordance with instructions from, and at no additional cost to, the Government.

After anchor bolt supports are stripped, bolt threads shall be cleaned, coated with grease, wrapped with burlap, and securely tied.

D3.6 Production of Concrete

D3.6.1 Ready-Mixed Concrete

Concrete shall be ready-mixed concrete; and, except as otherwise specified herein, ready-mixed concrete shall be batched, mixed, and transported in accordance with ASTM C94. Plant equipment and facilities shall conform to the “Check List for Certification of Ready-Mixed Concrete Production Facilities” of the National Ready Mixed Concrete Association.

D3.6.2 Tempering and Control of Mixing Water

Concrete shall be mixed only in quantities for immediate use. Concrete that has set shall not be re-tempered, but shall be discarded.

Water may be added to concrete with slump below that suitable for placing only if neither the maximum permissible water-cement ratio nor the maximum slump is exceeded. Additional water, when permitted, shall be incorporated by additional mixing equal to at least one-half of the total mixing period specified.

When specifically approved by the Government, water, in excess of that permitted by the limitation of the water-cement ratio, may be added provided that such water is accompanied by a quantity of cement sufficient to maintain the proper water-cement ratio.

D3.6.3 Weather Conditions

D3.6.3.1 Normal Weather Requirements

When conditions are such that the ambient temperature is between 40 degrees F and 90 degrees F, conformance to the recommendations of ACI 304 as modified herein is required. Temperature of the concrete, at points of delivery, shall not be lower than
50 degrees F and shall not be higher than 90 degrees F. As required, approved methods of heating or cooling mixing water and/or aggregates shall be utilized.

D3.6.3.2 Cold Weather Requirements

When conditions are such that the ambient temperature may be expected to be 40 degrees F or lower during batching and mixing of concrete, or when required by the Government, conformance to the recommendations of ACI 306R as modified herein shall be required; steam generators or other approved means for heating mixing water or aggregates or both shall be utilized. Materials containing frozen lumps, ice, or snow shall not enter the batches. Temperature of the concrete at the points of delivery shall not be less than 50 degrees F. The maximum temperature of the concrete shall not exceed 90 degrees F. Temperature of mixing water shall not exceed 140 degrees F; temperature of aggregates shall not exceed 150 degrees F.

D3.6.3.3 Hot Weather Requirements

When conditions are such that the ambient temperature may be expected to be 90 degrees F or higher during batching and mixing of concrete, or when required by the Government, conformance to the recommendations of ACI 305R as modified herein shall be required; pre-cooling of aggregate or mixing water or both shall be utilized. Temperature of the concrete at points of delivery shall not be more than 90 degrees F. Mixing time shall be kept to the specified minimum. When ice is used for cooling mixing water, it shall be shredded ice and shall be limited to a maximum of 90 percent of the total water. At the point of discharge, there shall be no evidence of ice remaining in the mix; if there is ice remaining after the maximum revolutions have been reached, the batch shall be rejected.

D3.7 Quality Assurance

Quality assurance measures as are necessary to ensure that the work conforms to this Specification shall be required.

D4.0 INSTALLATION

D4.1 General

Approved site drawings shall indicate the compressive strengths required of all concrete utilized.

Government inspection shall be required after Government receipt of written notification of concrete placement and a request for final inspection. Notification of placement shall imply completion of all work required to be complete prior to placement of concrete. Notification shall also contain any additional, pertinent information required by the Government.

Placement of concrete shall conform to the recommendations of ACI 304 and the requirements of this section of the Specification.

D4.2 Preparation Before Placing

Hardened concrete and foreign materials shall be removed from the inner surfaces of conveying equipment prior to placement.

All formwork required for the placement shall be complete. Formwork shall be free of snow, ice, and water. Reinforcement shall be securely in place. Expansion joint filler, anchors, sleeves, inserts, anchor bolts, and all other embedded items shall be accurately secured in position. The entire preparation shall be inspected and approved by the Government.

Concrete shall not be placed on frozen ground. Semiporous subgrades shall be sprinkled with water sufficiently to eliminate suction. Porous-subgrades shall be sealed as approved by the Government.

D4.3 Conveying

Concrete shall be handled from the mixer to the place of final deposit as rapidly as practical by methods that shall prevent segregation of loss of ingredients, and in a manner that shall assure that the required quality of the concrete is maintained.

D4.4 Depositing

D4.4.1 General

Concrete shall be deposited in the forms in accordance with the recommendations of ACI 304. Concrete shall be deposited continuously, or in layers of such thickness that no concrete shall be deposited on concrete that has hardened sufficiently to cause the formation of cold joints within the section.

Placing of concrete shall be at such a rate that the concrete being integrated with fresh concrete is still plastic. Concrete that had partially hardened, or has been contaminated by foreign materials shall not be deposited.

Concrete mixed in stationary mixers and transported by nonagitating equipment shall be placed in forms within 45 minutes from the time ingredients are charged into the mixing drum. Concrete that is truck mixed or transported in truck mixers or truck agitators shall be delivered to the site of the work and discharge completed into the forms within the time specified in ASTM C94, except that when the concrete temperature exceeds 85 degrees F, the time shall be reduced to 45 minutes. Batched cement and aggregates transported to the site shall be placed in the forms within one and one-half hours after cement has been added. Concrete shall be placed in the forms within 15 minutes after discharge from the mixer at the jobsite.

D4.4.2 Segregation

Concrete shall be deposited as nearly as practical in its final position to avoid segregation due to re-handling or flowing. Concrete shall not be subjected to any procedure that causes segregation.

D4.4.3 Consolidation

Consolidation of concrete shall be in accordance with the recommendations of ACI 309 and the requirements specified herein. Except as otherwise specified, all concrete shall be consolidated by vibration. Consolidation shall be such that the concrete is
thoroughly worked around the reinforcement, around embedded items, and into the corners of forms, eliminating all air or stone pockets that may cause honeycombing, pitting, or planes of weakness.

Internal vibrators used shall be the largest size and the most powerful that can be used for the work, as recommended in ACI 309. Vibrators shall not be used to transport

concrete within the forms. Vibrators shall be inserted and withdrawn at points approximately 18-inches apart. At each insertion, the duration shall be sufficient to consolidate the concrete without causing segregation. Each layer of concrete shall be consolidated, as specified, immediately after placing.

Where concrete is to have an as-cast finish, a full surface of mortar shall be brought against the form by the vibration process, supplemented, if necessary, by spading to work the coarse aggregate back from the formed surface.

D4.4.4 Protection

Concrete shall not be placed during rain, sleet, or snow unless adequate protection is provided. All procedures and protective measures shall be subject to approval by the Government. Rainwater shall not be allowed to increase the mixing water, nor to damage the surface finish of the concrete.

D4.4.4.1 Normal Weather Requirements

When conditions are such that ambient temperature is between 40 degrees F and 90 degrees F, temperature of concrete, when placed, shall not be lower than 50 degrees F nor higher than 90 degrees F.

D4.4.4.2 Cold Weather Requirements

When conditions are such that ambient air temperature may be expected to be 40 degrees F or lower during the placing or during the curing period, conformance to the recommendations of ACI 306R as modified herein is required.

The temperature of the concrete when placed shall not be less than 50 degrees F nor more than 90 degrees F. Suitable covering and/or other means, as approved by the Government, shall be provided to maintain the concrete at a temperature of at least 50 degrees F for the curing period. Chemicals shall not be added to the concrete to prevent freezing. Any concrete damaged by freezing shall be removed and replaced at no additional cost to the Government. All exposed finished concrete surfaces and embedded items shall be protected from damage due to freezing of collected water.

D4.4.4.3 Hot Weather Requirements

When conditions are such that the ambient air temperature may be expected to be 90 degrees F or higher during placing or during the curing period, conformance to the recommendations of ACI 305R as modified herein shall be required.

The temperature of the concrete when placed shall not be more than 90 degrees F. If ice is used as a replacement for all or part of the mixing water, there shall be no evidence of such ice at the time that concrete is ready to be placed. Retarding admixture, if approved by the Government, shall be as specified. Suitable covering and/or other means, as approved by the Government, shall be provided for the protection of the concrete against accelerated evaporation. Any concrete damaged by accelerated evaporation shall be removed and replaced at no additional cost to the Government.

When the temperature of the steel (reinforcement, embedded items, steel forms) is greater than 120 degrees F, reinforcement, embedded steel, and steel forms shall be sprayed with water just prior to the placing of concrete.

D4.4.5 Bonding

The surface of construction joints shall be prepared in accordance with D3.5.1. and the requirements specified herein.

Except as otherwise required or approved by the Government, hardened concrete at construction joints shall be dampened (but not saturated) and then thoroughly covered with a coat of cement grout of similar proportions to the concrete. The grout shall be at least one-half inch thick on horizontal surfaces. The fresh concrete shall be placed before the grout has attained its initial set.

Joints receiving an adhesive, as required or approved by the Government, shall have been prepared, and adhesive applied, in accordance with the manufacturer’s recommendations, prior to placing of fresh concrete.

D4.5 Repair of Defects

D4.5.1 General

Surface defects and tie holes shall be repaired, as specified herein, within 24 hours after removal of forms, unless otherwise approved by the Government. Ambient air

temperature, and temperature of the concrete and repair mortar shall not be less than 50 degrees F nor more than 90 degrees F during repair and curing.

Defects determined by the Government to exceed surface defects (e.g., defects that extend to a depth such that reinforcement steel is exposed) shall be repaired.

D4.5.2 Repair of Surface Defects

All honeycombed and other defective concrete in surface defects shall be removed down to sound concrete. As required, edges shall be chipped perpendicular to the surface, or slightly undercut; no feather edges shall be permitted. The area to be patched, and an area at least six-inches wide surrounding it, shall be dampened to prevent absorption of water from the patching mortar. Bonding grout, consisting of one part cement to one part fine sand (passing a No. 30 sieve) mixed to a consistency of thick cream, shall be well brushed into the surface to be patched after surface water has evaporated from the area.

Patching mortar shall be made from the same materials as the concrete; mix shall be not more than one part cement to two and one-half parts sand by damp loose volume. White Portland cement shall be substituted for a part of the gray Portland cement on exposed surfaces to match the surrounding concrete; color match shall be determined by a trial patch. Mixing water, for patching mortar, shall be no more than necessary for handling and placing.

Patching mortar shall be at the stiffest consistency achievable to permit placing.

Patching mortar shall be applied when the bond coat begins to lose its water sheen. Mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface. The patch shall be left undisturbed for at least one hour, to permit initial shrinkage, before final finishing. Patched area shall be kept damp for seven days. Metal tools shall not be used to finish a patch in a formed surface that will be exposed to the environment.

D4.5.3 Tie Holes

Tie holes shall be cleaned, thoroughly dampened, and filled solid with patching mortar, as specified in D4.5.2.

D4.6 Finishing of Formed Surfaces

D4.6.1 General

Approved site drawings shall identify the locations of concrete surfaces to be finished after removal of forms.

If finished requirements are not indicated on the approved site drawings, “Rough Form Finish” shall be used for concrete surfaces not exposed to view in the finished work, and “Smooth Form Finish” shall be used for concrete surfaces to be exposed to view in the finished work.

D4.6.2 As-Cast Finishes

D4.6.2.1 Rough Form Finish

Form surface shall produce a concrete finish equivalent to that produced by sound, tight lumber. Tie hoes and surface defects shall be patched as specified. Fins exceeding one-quarter inch in height shall be chipped, or rubbed, off.

D4.6.2.2 Smooth Form Finish

Form surfaces in contact with concrete shall be of a material that is non-reactive with concrete and produces a smooth, hard, uniformly textured surface. Form facing material may be plywood, tempered concrete-form-grade hardboard, metal, plastic, or other material capable of producing the specified finish.

D4.7 Slabs

D4.7.1 Preparation of Subgrade

Subgrade shall be well drained and free of frost, and shall be subject to approval of the Government, before placement of concrete. The bottom of an undrained granular base course shall not be lower than the adjacent finished grade.

Subgrade shall be moist at the time of concrete placement. As required, it shall be dampened prior to concreting, but there shall be no free water standing on the subgrade, or muddy or soft spots, when concrete is placed.

Approved site drawings shall indicate where polyethylene sheet vapor barriers, conforming to ASTM D2103, shall be installed beneath slabs to be supported on grade. Vapor barrier shall be of not less than six-mil nominal thickness and shall be installed with edges lapped not less than four inches and sealed with a compatible pressure sensitive tape, not less than two-inches wide.

D4.7.2 Placement

Placing of concrete shall be coordinated with finishing requirements. Concrete shall not be placed on the subgrade or within the forms more rapidly than it can be spread, straightedged, and darbied or bull floated. These operations shall be performed before bleeding water collapses on the surface.

Finishing shall progress at the rate required to prevent cold joints and to obtain good concrete surfaces. The effects of concrete temperature and atmospheric conditions on the rate of hardening of the concrete shall be considered in determining the required size of finishing crews. If construction joints are required, they shall be as specified in D3.5.1.

D4.7.3 Jointing

Approved site drawings shall indicate where joints shall be located and constructed in sidewalk.

D4.7.4 Consolidation

Concrete in slabs shall be thoroughly consolidated in accordance with the recommendations of ACI 309. Consolidation of slabs shall be obtained with vibrating screeds, roller type screeds, internal vibrators, or as otherwise approved by the Government.

D4.7.5 Finishes

D4.7.5.1 General

The ambient air temperature during, and in the area of, finishing operations shall not be less than 50 degrees F. Finish surfaces shall not be dusted with dry materials nor flooded with additional water. Approved site drawings shall indicate finishes as specified herein. Tolerances shall be as specified in D4.7.7. Materials, other than special aggregates, shall be as specified in D3.1.

D4.7.5.2 Floated Finish

Floated finish shall be applied to surfaces that have been struck off and leveled. Floating with a hand float, or a bladed power trowel equipped with float shoes, or with a powered disc float shall begin when the water sheen has disappeared and when the surface has stiffened sufficiently to permit the operation.

During or after the first floating, planeness of surface shall be checked. High spots shall be cut down, and low spots shall be filled such that the surface meets the requirements for Class A tolerance. The slab shall then be refloated immediately to a uniform sandy texture.

D4.7.5.3 Troweled Finish

Troweled finish shall be applied to surfaces that have been float finished as specified in D4.7.5.2. Surfaces meeting the requirements of D4.7.5.2 shall be power troweled and then hand troweled. Hand troweling operations shall thoroughly consolidate the surface and shall be repeated as required to produce a finished surface that is free of defects and trowel marks and is uniform in texture and appearance. The concrete surface shall be finished to a Class A tolerance.

D4.7.5.4 Broom or Belt Finish

Broom or belt finish shall be applied to surfaces that have been float finished as specified in D4.7.5.2. The surface shall be given a coarse transverse scored texture by drawing a broom or burlap belt across it immediately after completion of float finishing operations.

D4.7.6 Unspecified Finish

When the type of finish is not indicated on the approved site drawings, slab surfaces shall receive a troweled finish as specified in D4.7.5.3.

D4.7.7 Finishing Tolerances

Finishes with Class A tolerances shall be true planes within
one-eighth inch in ten feet, as determined by a ten-foot straight edge placed anywhere on the slab in any direction.

D4.8 Curing and Protection

D4.8.1 General

Immediately after placement, concrete shall be protected from premature drying, excessive hot or cold temperatures, and mechanical injury; and, shall be maintained with minimal moisture loss, at a relatively constant temperature for the period
necessary for hydration of the cement and hardening of the concrete. Materials and methods of curing shall be in accordance with the recommendations of ACI 308, and shall be subject to approval by the Government.

D4.8.2 Curing

Immediately after placement and finishing of concrete, surfaces not in contact with forms shall be cured by the use of one of the following procedures:

a. Ponding or continuous sprinkling;

b. Application of waterproof sheet materials, conforming to ASTM C171;

c. Application of other moisture-retaining covering as approved by the Government; or

d. Application of a membrane curing compound, conforming to ASTM C309. Compound shall be applied in accordance with manufacturer's recommendations immediately after any water sheen, developed after finishing, has disappeared from the concrete surface. Curing compounds shall not be used on any surface against which additional concrete or other material is to be bonded unless it is proven, to the satisfaction of the Government, that the curing compound shall not prevent bond, or unless it can be completely removed from areas to receive bonded applications. Curing compounds that could result in discoloration of surfaces to be exposed in the finished work shall not be used.

Moisture loss from surfaces placed against wood or metal forms exposed to heating by the sun shall be minimized by keeping the forms wet until their removal. After form removal, concrete shall continue to be cured, as specified in D4.8.2, until the end of the time period specified in D4.8.2.

Curing, as specified in D4.8.2, shall be continued for at least seven days. Concrete cured initially by procedures specified in D4.8.2, may be continued to be cured by any

other procedure specified in D4.8.2 provided that the concrete is at least one day old when the curing procedure is changed; and, that the concrete is not permitted to become surface dry during the transition.

D4.8.3 Temperature, Wind, and Humidity

D4.8.3.1 Cold Weather Requirements

When the mean daily outdoor temperature is less than 40 degrees F, the temperature of the concrete shall be maintained between 50 and 70 degrees F for the required curing period, as specified in D4.8.2. Curing requirements and methods shall conform to the recommendations of ACI 306R and shall be subject to approval by the Government.

Arrangements for heating, covering, insulating, or housing the concrete Work shall be made in advance of placement and shall be adequate to maintain the required temperature without injury due to concentration of heat. Combustion heaters shall not be used during the first 24 hours unless precautions are taken to prevent exposure of the concrete to exhaust gases that contain carbon dioxide.

D4.8.3.2 Hot Weather Requirements

When hot weather conditions exist, as determined by the Government, curing requirements and methods shall conform to the recommendations of ACI 305R and shall be subject to approval by the Government.

Provision for windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as concrete hardening, and finishing operations, allow.

D4.8.3.3 Rate of Temperature Change

Changes in temperature of the air, immediately adjacent to the concrete, during and for the first 24 hours following the curing period, shall be kept as uniform as possible. The rate of change shall not exceed 5 degrees F in any one hour, or 50 degrees F in any 24-hour period.

D5.0 TESTING

D5.1 General

Testing agencies shall conform to the requirements of ASTM E329 and shall be in accordance with the requirements specified herein.

Concrete and construction operations shall be tested and inspected as the work progresses. Failure to detect any defective work or materials shall not in any way prevent later rejection when such defect is discovered, nor shall it obligate the Government for final acceptance.

Testing services shall be performed by a testing agency approved by the Government. Qualifications of the testing agency shall be submitted for approval.

Testing services shall be provided for the evaluation of proposed concrete. Test reports provided by the testing service shall certify conformance with the requirements of this Specification. The Government will have the right to check-test proposed materials and procedures as required by this section of the Specification; the Government shall have access to the work for any testing and inspection.

D5.2 Slump Test

Slump of concrete shall be tested in accordance with the requirements in ASTM C143. Concrete samples shall be taken during concrete placement. Tests shall be performed at commencement of concrete placement, when test cylinders are made, and for each batch of concrete required to produce each panel or section.

D5.3 Compressive Strength Tests

Compressive strength of concrete shall be tested in accordance with the requirements in ASTM C39, Tables D6-1 and D6-2, and such additional testing as may be required to verify conformance with the requirements of this section of the Specification. Concrete required for testing purposes shall be supplied. Facilities for storing and curing concrete test specimens shall be supplied and be adequate for onsite storage for the first 24 hours, as required by ASTM C31 testing requirements. Three test cylinders for each set of tests in accordance with ASTM C31 are required. Test two cylinders at 28 days and one cylinder at 7 days for information. When high early strength concrete is used, a fourth cylinder shall be obtained for each set of accelerated strength tests.

Conformance to concrete strength requirements specified in this section of the Specification shall be based on strength test results as required by ACI 318 for evaluation and acceptance of structure concrete.

If the results of strength tests indicate that concrete already placed does not meet specified requirements, and if so directed by the Government, core tests and/or load tests, as required by ACI 318, shall be performed.

Testing and analysis necessitated by strength test results indicating deficient concrete shall be conducted at no additional cost to the Government.

Concrete work judged, by structural analysis or load test, to be inadequate due to deficient concrete shall be reinforced or replaced, as directed by the Government, and at no additional cost to the Government.

D5.4 Inspection

The work to be provided in accordance with this section of the Specification shall be subject to inspection by the Government at any time(s) during the progress of the work. Access shall be provided to the Government, and any support, materials, tools, and equipment required by the Government to complete inspection of the work as specified herein shall be provided at no additional cost to the Government.

All structures shall meet the requirements of the Specification as indicated by the results of testing, inspection, and other quality assurance procedures required by the Government.

Approval, by the Government, of any remedial measures shall not be construed to mean approval of the results of such remedies.

Modifications resulting from any remedial measures performed shall be subject to the approval of the Government.

Tolerances specified herein for placing of reinforcement are individual maximums and shall not be construed to permit the accumulation of any group of tolerances that infringe on any of the specified maximums. The work shall meet all tolerance requirements.

D6.0 CONCRETE FOUNDATION TEST, QUALIFICATION, AND DESIGN APPROVAL REQUIREMENTS

D6.1 Concrete Foundation Test Requirements

Concrete tests for specific concrete parameters shall be conducted for all foundations in accordance with the foundation group test repetition requirements of Table D6-1 and with the test parameter requirements of Table D6-2.

Table D6-1 Foundation Group Test Repetition Requirements

FOUNDATION GROUP	TEST REPETITION REQUIREMENTS
Radar Tower Foundations	5 Sets (minimum)
Shelter Foundations	Note (1)
Any Additional Foundations	Note (1)

Note 1: A minimum of two sets of tests shall be conducted per foundation group. If two or more foundations are poured in one day, a minimum of two sets of tests shall be conducted for the first 50 cubic yards of concrete, per mix design per day. A minimum of one set of tests shall be conducted for each additional 50 cubic yards.

Table D6-2 Concrete Parameter Test Requirements

TEST PARAMETER	TEST REQUIREMENT		
	LOCATION	FREQUENCY	COMMENTS
Air Content	On-Site	(Note 2)	N/A
Slump	On-Site	(Note 2)	(Note 4)
Temperature	On-Site	(Note 2)	N/A
Compressive Test Sample Sets (Note 1)	N/A	(Note 3)	N/A

Note 1: One test shall be performed at seven days for information; two tests shall be performed at 28 days to validate that concrete has met or exceeded the compressive test requirements.

Note 2: Test samples shall be taken prior to any placement of concrete, and with each set of cylinders.

Note 3: Samples shall be taken on site and tested at the testing laboratory after being cured in accordance with ACI 308.

Note 4: Slump of the concrete sample shall be determined for each strength test and whenever consistency appears to vary.

N/A: Not Applicable

D6.2 Concrete Qualification Requirements

Concrete qualification requirements shall be as described in Table D6-3.

Table D6-3 Concrete Qualification Requirements

REQUIREMENT	SPECIFICATION SECTION REFERENCE
Concrete admixtures	D3.1.4
Requirements for concrete mixes	D2.3, D3.1 to D3.2.6 inclusive, and D6.0
Certified test data and reports for materials and compressive strengths of mix designs	D5.1
Approved site drawings of reinforcement steel	D3.4.1
Testing agency requirements	D5.1
Descriptive data, samples, certified test reports, and manufacturer's certification of compliance with specified requirements for the following: Reinforcing steel, joint filler, joint sealer, vapor barrier, sheet materials for concrete curing, and membrane curing compounds	D3.4, D3.5, D4.7.1, and D4.8.2
Requalification of materials or mix proportions required as a result of changes or test failures, as follows: a. Mix proportions b. Test Reports	D3.2, D5.0
Certified test reports of cores and/or load tests	D5.0, D6.0

D6.3 Concrete Design Approval Requirements

An approved mix design,, (as well as compaction test results for subgrade), shall be required prior to submission (to the Government) of the 72-hour notice for placing concrete. The minimum submittal requirements include the proposed concrete mix design along with documented certification that requirements of Table D6-4 shall be met.

Table D6-4 Concrete Mix Design Approval Requirements

SECTION REFERENCE	ITEM	ASTM/ACI NUMBER	REQUIREMENT
D3.1.1	Cement	C150	Type II (no flyash permitted
D3.1.2	Coarse aggregate	C33	Provide gradation
D3.1.2	Fine aggregate	C33	Provide gradation
D3.1.4	Air entraining agent	C260	Meets ASTM requirements
	Water reducing, retarding of accelerating admixtures	C494	Meets ASTM requirements
	Other admixtures		Provide description (must be free of chlorides)
D3.2.4	Air content	ACI 318	See ACI table 4.1.1
D3.2.4	Slump		4" (Max)
D4.7.1	Vapor barrier	D2103	As required
D4.8.2	Curing Compound	C309	As required